Adaptive Oceanographic Sampling in a Coastal Environment Using Autonomous Gliding Vehicles

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LONG-TERM GOALS

Our long-term goal is to develop a flexible system of autonomous underwater vehicles suitable for extended oceanographic exploration anywhere in the global ocean. Particular emphasis is placed on the development and application of high-endurance, low-cost, intelligent vehicles capable of coordinated operation within the framework of an autonomous oceanographic sampling network. Our research strategy is to combine technology development activities with well-defined and important oceanographic research efforts through a series of increasingly complex field experiments.

OBJECTIVES

The primary objective of this program is to demonstrate moderate-term (weeks) operation of a multi-vehicle network of Slocum autonomous gliders in a coastal environment. Secondary objectives include continued development of a adaptive sampling strategies suitable for large fleets of slow-moving autonomous vehicles.

APPROACH

We will construct and operate a network of autonomous gliding vehicles in the Atlantic Ocean south of Martha's Vineyard. Three Slocum gliders will be used to characterize the three-dimensional, time-dependent structure of the shelfbreak front in the Mid-Atlantic Bight over a one-year period, while simultaneously measuring physical and optical properties across the width of the New England continental shelf.

WORK COMPLETED

The main task completed this year was a complete redesign of the Slocum vehicle incorporating significant improvements in modularity and robustness. Major improvements include addition of a modular science payload bay with a dedicated computer system, integration of acoustic transducers in the bow cone for underwater communications, and addition of a servo-controlled rudder for improved lateral control. One of these new generation vehicles has been delivered by the manufacturer (Webb Research Corp.) and two others are in the final stages of assembly.

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14. ABSTRACT

Our long-term goal is to develop a flexible system of autonomous underwater vehicles suitable for extended oceanographic exploration anywhere in the global ocean. Particular emphasis is placed on the development and application of high-endurance, low-cost, intelligent vehicles capable of coordinated operation within the framework of an autonomous oceanographic sampling network. Our research strategy is to combine technology development activities with well-defined and important oceanographic research efforts through a series of increasingly complex field experiments.

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We have completed the backbone of an integrated glider data management system. This system is now in routine use in our laboratory and has been linked with a web-based front-end for near-real-time data distribution via the internet and integration with assimilating numerical models. We have developed a desktop-based mission simulator which allows efficient prototyping of adaptive sampling algorithms and multiple-vehicle interaction with arbitrary, realistic environmental forcing (winds, tides, currents, etc.). Development of global satellite communications capability (Iridium) is ongoing and is viewed as a critical requirement prior to long-term unattended operation.

RESULTS

An electrically-powered Slocum vehicle was successfully deployed at the LEO-15 site in Tuckerton, New Jersey during July 2000. The vehicle was operated continuously for 10 days while collecting high-quality CTD data (equivalent to 5,100 individual profiles) in water 10-20 m deep. This data was subsequently disseminated via the internet and assimilated into a regional ocean prediction model.

IMPACT/APPLICATIONS

The development of the Slocum glider will facilitate extended oceanographic research in remote locations that are physically or economically difficult to visit with manned research vessels. Continued development of multi-vehicle network operation will enable autonomous, adaptive measurement of time-dependant or transient ocean phenomena such as mesoscale eddies and fronts. In the future, we believe a network of autonomous gliding vehicles will supply, in an efficient and cost-effective manner, high-quality, near-real-time environmental information for operational ocean/atmosphere forecasting and model validation.

RELATED PROJECTS

A companion observing network based on environmentally-powered Slocum gliders is being developed near the BATS site south of Bermuda. We anticipate that continued parallel development of these closely-related vehicle systems will yield rapid improvements in vehicle performance and observational capabilities.

PUBLICATIONS

Fratantoni, D.M. and D.A. Glickson, *The Slocum Autonomous Glider*, abstract submitted to AGU Fall Meeting, San Francisco, CA, December 2000.

Figure 1: Redesigned Slocum electric glider. Major improvements include addition of a modular science payload bay (center section) with a dedicated computer system, integration of acoustic transducers in the bow cone for underwater communications, and addition of a servo-controlled rudder for improved lateral control.